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## SEX DIFFERENCES IN THE TAPPING TEST: AN INTERPRETATION

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While it is doubtful if we ought to attach to the speed of repeated voluntary movements the fundamental significance accorded to it by some of its earlier investigators, certain sex differences have appeared in the writer's experience with the test that would seem to justify a brief presentation. The subjects whose results form the basis of the present discussion are ten men and ten women, with two exceptions nurses in the McLean Hospital, and of corresponding age and environmental level. It would be very difficult under other conditions than the present to equal these groups of subjects in homogeneity, co-operativeness, and unaccustomedness to the conditions of psychological experiment. For this reason, a significance may perhaps be attached to the present results which the limited number of subjects might otherwise largely vitiate.

The experiments with the ten men have already been described in detail,<sup>1</sup> and those with the ten women are essentially similar. Two experiments are performed with each subject, each consisting of five 30" series of tapping with each hand, the right hand preceding in the first experiment and the left hand preceding in the second experiment. From the results of these experiments as performed, we derive various functions, the principal ones with which we are here concerned being as follows:

1. The relation to each other, in respect to gross rate, of five successive 30" series of tapping with the same hand, the series being separated by rest intervals of 2' 30".

2. The gross fatigue effect, as given in the "index of fatigue," ( $f$ ) which index is derived by dividing the average number of taps in the last five 5" intervals (25" of tapping) by the number in the first 5" interval.

3. The fatigue curve, or curve of the decrease in the number of taps executed during the six successive 5" intervals of a 30" series.

4. The relation of the right hand to the left hand, as given in the "index of right-handedness" which is the average num-

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<sup>1</sup>*American Journal of Psychology*, XIX, 1908, pp. 437 ff.

ber of taps executed in five successive 30" series by the left hand, divided by the corresponding average for the right. The higher this index, the better the left hand in proportion to the right; above 1.00 the left is absolutely superior to the right.

5. The mean variation of successive experiments in the same individual, *i. e.*, the constancy of his results to each other.

We shall first examine those aspects of the results concerned with differences in the average of performance, and later those functions which deal with the relative variability of the sexes about these averages.

The previous researches which afford material for the study of sex differences in the tapping rate are concerned mainly with children and adolescents. While they do not maintain absolute correspondence, their general indication is that the boys are faster than the girls, and that the sex difference increases with age, so that we should expect to find here a consistent superiority of the men over the women.

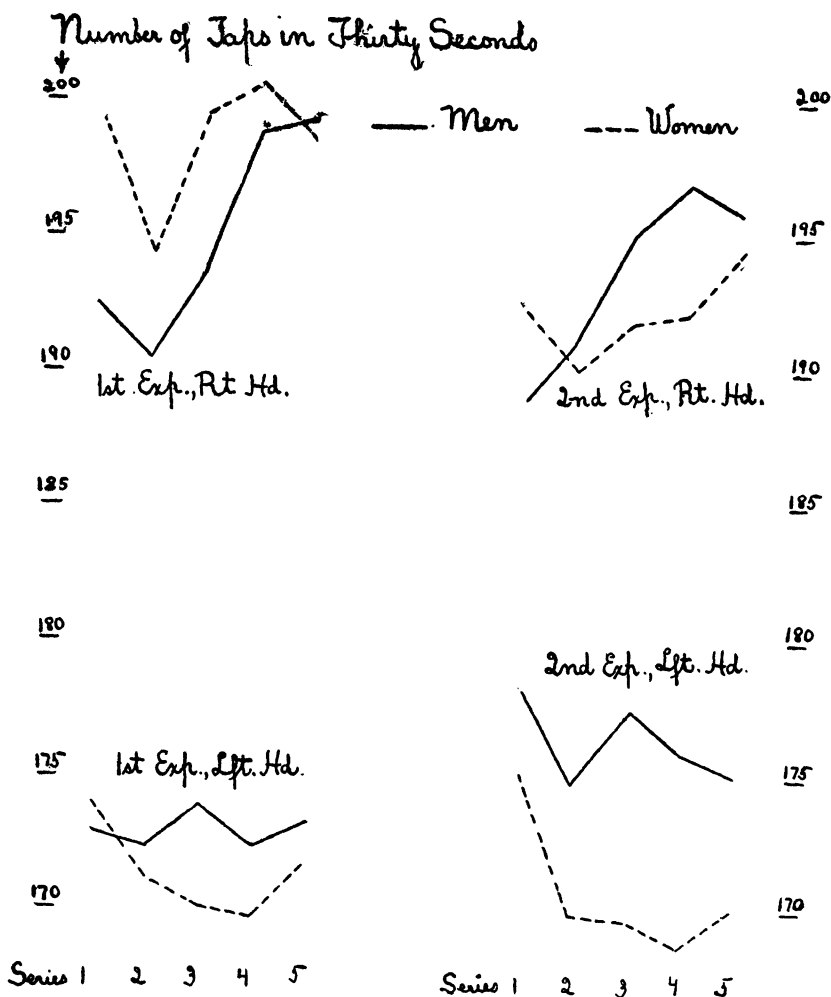
The actual results are best presented in the form of curves, which give the total number of taps executed in each of five successive 30" series of tapping. The continuous lines represent the tapping rates of the men, the dotted lines those of the women; the right and left hands, and first and second experiments being as indicated on the curves themselves. Thus in the first series of the first experiment with the right hand, the men execute 192.4 taps, the women 199.4; in the fifth (and last) series of the second experiment with the left hand, the men have 175.1 taps, the women 170. The curves give the fluctuations in rate from series to series. (Plate I.)

Briefly, the women surpass the men in the performance of the right hand in the first experiment. Elsewhere they are inferior, and they are much more inferior in the second experiment than in the first. The women are more favored in the first experiment, by virtue of its being the first, than the men, and they lose more in the second experiment, as such, than the men. The first experiment represented the first contact of any of the subjects with the test. There is thus of course a primary *Neuigkeitsantrieb* which is absent in the second experiment. This scarcely affects the men at all; indeed, their second experiment is as a whole somewhat better than the first. On the other hand, the women are in the second experiment markedly inferior to their first performance, in the absence of this *Neuigkeitsantrieb*.

There is a corresponding sex difference in the fluctuation in rate of the successive series, as illustrated in the curves. Just as the first experiment has a special *Neuigkeitsantrieb*, so is there a secondary *Anfangsantrieb* in the first series of each record of either hand. If the curves are examined, it will be

seen that this first series is, relatively to the rest of the curve, very much higher in the women than in the men; *i. e.*, the women also indicate more strongly the presence of this second-

PLATE I



dary *Anfangsantrieb*. The indication of *Schlussantrieb* at the conclusion of each experiment (the last series with the left hand in the first experiment, and that with the right hand in the second) is also more marked in the women.

As regards susceptibility to fatigue, previous studies, while differing somewhat from the present in manner of calculation, leave a slight balance of probability in favor of the men as the less susceptible to fatigue. As given in terms of the  $f$ , the present experiments average as follows :

Comparative  $f$ 's of the two groups.

	R1	R2	L1	L2
Men	.90	.91	.88	.90
Women	.90	.91	.87	.89

(In the tables, R1, R2, L1, L2 will be employed to indicate the first and second experiments with the right and left hands respectively.)

That is, the last 25" tapping averages from 87% to 91% as fast as the first 5". There is no immediate sex difference worth mentioning, especially when we find that the mean variations average about .03. Such infinitesimal differences as exist are in favor of greater fatigue immunity for the men. It is noticeable that in both men and women the left hand is more susceptible to fatigue than the right, and the first experiment more so than the second, this latter presumably a manifestation of less *Antrieb* in the second experiment.

The writer has previously mentioned that in the tapping test the fatigue phenomena seemed remarkably independent of the fatigue sensation accompanying the work. This generalization was based on experiments with men only, and the results with the women do not bear it out so well.<sup>1</sup> Each of the women was asked whether sensations of fatigue were present, and if so, in which hand they were the more prominent; it being then noted whether greater fatigue sensations on one side corresponded with greater fatigue phenomena on that side. The results were as follows.

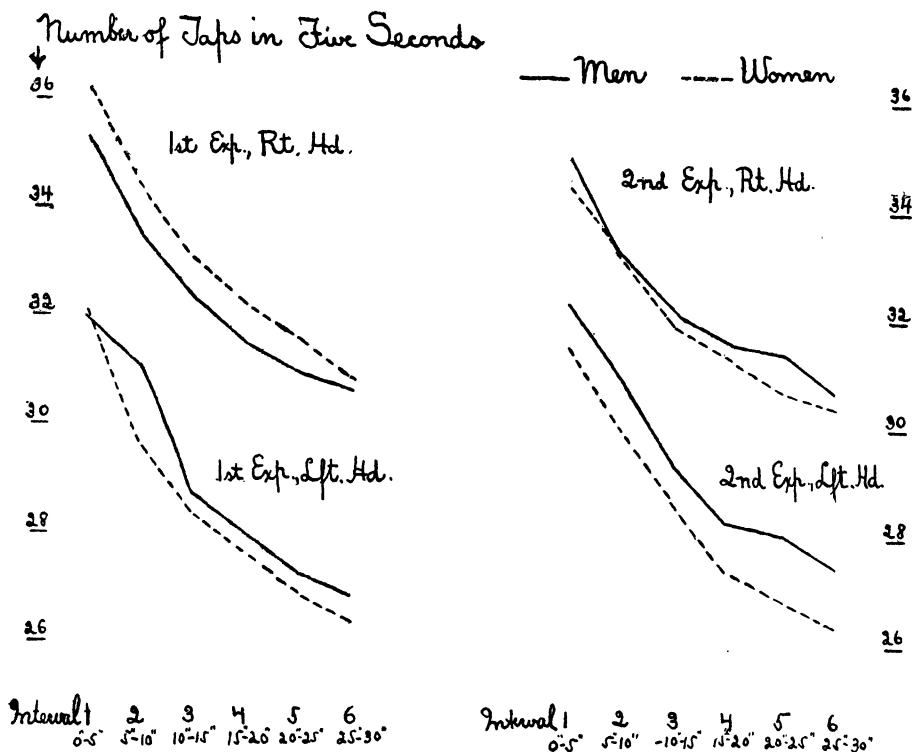
<i>Sensations of Fatigue</i>	<i>Phenomena of Fatigue</i>
None	No significant difference
Equal	Equal
Only in left	More in left
More in left	More in left
More in left	No significant difference
More in left	No significant difference
More in left	More in left
More "tension" in right	More in left
More in right	Equal
Probably more in right	More in left

We obtain a positive relation in five cases, four are equivo-

<sup>1</sup>The experiments with the men antedate those with the women by about a year.

cal, and one is negative. This correspondence, while by no means good, is rather better than seems to obtain among the men, though the inquiries with them were not so systematic. If there is a sex difference here, *i. e.*, in that the women's introspective account of fatigue sensation shows a better correspondence with the actual fatigue phenomena than that of the men, its most reasonable interpretation would seem to be that the women's performance is more influenced by fatigue sensation. It should be mentioned that subsequent features in the results on fatigability bear out this interpretation.

PLATE II



The accompanying cut shows the fatigue curves of the right and left hands in each experiment, the curves of the two groups of subjects being superposed. As previously, the continuous lines are the records of the men, the dotted lines those of the women. The curves are of the ordinary shape and

show no characteristic sex difference in form. The relative inferiority of the women in the second experiment, already mentioned, is again evident. Another sex difference may be mentioned here, namely that the women are more inferior to the men with the left hand than with the right, *i. e.*, the right and left hands are farther apart in the women than the men. In the gross, this difference is best expressed in the index of righthandedness, which averages as follows in the two experiments.

	1st Experiment	2nd Experiment
Men	.89	.91
Women	.87	.89

In both groups the index is higher in the second experiment than in the first; *i. e.*, the preceding hand is more favored as such. The writer has previously mentioned this as a normal property of the test; but it is more probably related to *Anfangsantrieb* than to any generalized fatigue effect upon the following hand. It is seen also that the index is throughout lower in the women, the difference being just at the limits of probable error. This shows again that for this function there is more bilateral asymmetry, the right and left hands are farther apart, in the women than in the men.

Up to the present we have been dealing with averages only, reserving the mean variations for separate discussion, since these have a special bearing upon the question of sex differences. It seems to be very generally accepted that at least in most aspects, individual differences tend to be greater in men than in women, and it may be worth while to examine the data from this point of view. Only the mean variations need be presented, since it would be hardly possible to consider the more minute features of the problem of variability from a basis of ten cases of each group.

In initial rate, *i. e.*, rate for the first 5", as well as in gross rate, *i. e.*, rate for the whole series of 30", the mean variations of the different groups are as follows.

	R <sub>1</sub>		R <sub>2</sub>		L <sub>1</sub>		L <sub>2</sub>	
	5"	30"	5"	30"	5"	30"	5"	30"
Men	3.3	14.0	3.9	14.3	3.0	17.6	3.5	15.9
Women	2.8	14.3	2.1	13.8	2.3	13.2	2.8	14.6

The women are practically throughout less variable than the men. In the m. v. of the gross rate (30") this difference is not so well marked, and for a reason that is worth analysis. Attention has already been called to the fact that there was in the men a marked tendency for fatigue to *decrease* the individual differences. This tendency is also present in the women, but very much less so than in the men; indeed, at the end of the 30" the variability of the two sexes is practically equal. Under fatigue,

the individual differences of the women become relatively greater than those of the men.

As it previously appeared that there was no characteristic sex difference in the average of the  $f$ 's, so here we fail to find it in their variability. The mean variations of the  $f$ 's are practically the same in men and women throughout. As may however be inferred from what has just preceded, this equality is purely superficial; the  $f$  itself shows no sex difference, but both of its factors (the first and the remaining five intervals) do. Inasmuch as the women are to a certain extent less variable in the initial interval, if they continued to be equally so throughout the rest of the fatigue curve, the m. v. of the  $f$ 's would show equally the smaller variability of the women; but, inasmuch as we find the variability of the  $f$ 's equal, or nearly so, it follows that the fatigue curves of the women have under fatigue gradually increased in variability relatively to those of the men.

Absolutely, the fatigue curves of the women (whose average is given in the cuts on p. 357) resemble each other in form somewhat the more closely, as is indicated in the fact that in the women the mean variations of the successive 5" intervals are consistently smaller than those of the men. It is in this, an important aspect of the results, that smaller variability of the women is the most unequivocally illustrated. The average m. v.'s of the six successive intervals in the two experiments for the men and women are as follows:

	R1	R2	L1	L2
Men	2.4	3.0	2.4	2.7
Women	2.1	1.9	2.3	2.4

In view of what has been said, however, it is more than probable that at the end of 60" of tapping the variability of the women would exceed that of the men.

It was noted previously that the right and left hands are farther apart in the women than in men. It is also observable that the difference between the right and left hands is more variable in the women than in the men, the figures being as follows.

	1st Experiment	2nd Experiment
Men	.035	.033
Women	.047	.041

The relationship of the two hands in these experiments is affected mainly by the matter of precedence of either hand in the test. We saw that this factor affected the tapping rates of the women somewhat more than those of the men, and we see here that it also affects them more variably than those of the men.



As an aspect of the same general result, it may be noted that the day to day variability in gross rate was in the women strikingly greater than in the men. Taking the mean variation of the two experiments performed for each hand in each subject, we obtain for the two experiments the following results in the men and the women.

	Right	Left
Men	1.6	3.5
Women	3.4	3.9

That is, the first and second experiments differed much more from each other in the women than in the men. (*Cf.* p.354.)

Considered individually, one could attach no special significance to these data as isolated facts; and it is much more reasonable to regard them as secondary to other characters of sex difference having a more fundamental value. The results are best discussed in their relation to two such characters, which may be cited according to Havelock Ellis, as the lesser variability of women, and the greater affectability of women. The latter is perhaps the most fundamental sex difference that exists on the psychical side, and indeed, were it not so apparent to everyday observation in general, it could be asserted positively for the group of subjects immediately concerned. This being the case, we must expect that the affective factor in every feature of the experimental conditions will influence the performance of the women to a significantly greater extent than it will those of the men. And in review of the points of sex difference previously mentioned, it seems that, as the sex differences appear most markedly in those features of the experiments in which the affective element is the most prominent, so are these differences most reasonably interpreted as the expression of this fundamental sex difference in affectability. It is, of course, possible to construct other hypotheses which will cover the various points of difference observed; but it is a precarious logical system which interprets with a variety of assumptions a series of observations referable to a known fact.

To this we must add, that besides being more affectable, the women were much more variable in their affectability than the men. This was clearly observable in the differences of experimental attitude. The women went at the test in much less of a routine manner; they more frequently evinced desire to examine and understand the apparatus, and were more likely to express concern as to the object and outcome of the tests, and regarding future experiments. The men showed a more uniform behavior in these respects than did the women, and their attitude toward the test was in general a more "objective" one. Among the women a varying amount of persuasion was occa-

sionally demanded; but it was always apparent that the subjects were really co-operative, and that the seeming inadequacy was wholly the product of an exaggerated affective reaction to the unaccustomed conditions of the experiment.

There are operative in these experiments four special affective influences: the precedence of the hands in the experiment, the sensations of fatigue, the use of the preferred or unpreferred hand, and the relative novelty of the test. The sex differences are marked principally according to the amount which these factors influence the special aspect of the results under consideration.

To particularize, the women are much more susceptible to the influences of *Antrieb* than are the men. The *Anfangsantrieb* of the inception of the experiment was illustrated in the record of the preceding right hand in the first experiment and perhaps even more strikingly so in the second experiment with the preceding left hand. As between the successive 30" series, the influence of a secondary *Anfangsantrieb* is apparent in that the first series of each hand is in the women relatively superior to the first series in the men. The apparent failure of the women to bear up so well under fatigue sensations indicates a heightened responsiveness to an affect of the opposite character.

If the greater difference between the right and left hands in the women is significant, an analogous interpretation is possible in that we perhaps try harder in doing what we expect to do better. The subjects naturally expect to do better with the right hand, and so try harder with it; the women, on an average, harder than the men. In a more affectable group, the hands might thus appear, in general, farther apart.

There are certain features of the test which we should hardly expect to be influenced by these differences in affectability, and which in fact do not seem to be so. The individual differences in tapping rate are slightly greater in the men than in the women, and the form of the fatigue curve is also more constant in the men, though it tends to become less so. Here we seem to have a sex difference referable rather to the generally lesser variability of women, already mentioned as a fundamental sex difference. In the remaining results, however, we find this general tendency toward lesser variability in women in conflict with the special factor of the greater affective variability of the women, and we shall find that in these cases, this latter factor is sufficiently potent to more than offset the other, so that the final figures show from almost every viewpoint, a lesser variability of the men.

Mention has been made of the fact that under fatigue the individual differences of the women do not show the same

tendency to decrease as those of the men. As we previously judged the women to be more responsive to sensations of fatigue than the men, we now find them to vary more in their responsiveness to them than the men, the former being an aspect of the women's greater affectability, the latter of their greater affective variability. And as we found the right and left hands to be farther apart in women than in men, so now we find the index of righthandedness to be more variable in women than in men; the greater difference a product of greater affectability, the greater variability of the difference a product of the greater affective variability.

The greatest affective difference that is objectively given in these tests is perhaps that between the first and second experiments; certainly the sex difference is very well marked here, the women being relatively much better in the first experiment than in the second. The women respond readily to the *Neuigkeitsantrieb* of the first experiment, and miss more strongly the interest of novelty in the second; a more even experimental attitude is indicated in the men.

To briefly recapitulate, no immediate sex difference was indicated in the absolute rate of tapping, in the gross amount of fatigue loss during the 30'' period, or in the form of the curve of this fatigue loss. More detailed examination of the results, however, indicated sex difference as follows:

1. The women relatively surpass the men in those periods of work most likely to be subject to special *Antriebe*.

2. The introspective accounts of the fatigue sensations given by the women agree better with the objective fatigue phenomena than those of the men seem to do; hence the women are probably more influenced by fatigue sensation than the men.

3. The right and left hands are farther apart in women than in men.

4. In initial rate (5'') the women are considerably less variable, in the gross rate (30'') slightly less variable than the men.

5. In the 30'' work period employed, the shape of the work curve is considerably less variable in the women than in the men, but the women show a tendency to relatively increasing variability under fatigue. (Cf. 2.)

6. The relationship of the right and left hands is more variable in the women than in the men.

7. The first and second experiments differ more from each other in the women than in the men.

The above sex differences are found mainly in those features of the experiment which especially involve the affective factor in the subject's attitude; and they are manifestations of the greater responsiveness of the women to this affective element.

When this factor is not especially involved, the individual differences of the women tend to be less than those of the men; but when it is involved they are greater, illustrating not only the presence of greater affect among the women, but also the greater variability of this affect. Thus the differences found are not fundamental sex differences, but are secondary to certain differences in temperament; and in a group of subjects in which these temperamental differences were by any chance reversed, we should expect to see the experimental differences also reversed.

It is very possible that a practiced experimenter can interpret these temperamental differences in the subjective attitude from observations of the general behavior under experimental conditions more reliably than through the crude introspection of a naïve subject. And though introspective accounts of the subjective attitude often seems to add little enough to the significance of the experiment, we might still be exposed to grave error in concluding from this that the subjective attitude does not still influence the results of such observations to a marked degree. In the foregoing, it has been endeavored to indicate the extent to which certain rather elementary motor functions might be influenced by what is perhaps the most important single factor in the subjective attitude, its susceptibility to affective influences.